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Digital Communications

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Computer Assignment 2

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Ordibehesht 01

Abstract

In this assignment, we start with designing a function to create the Raised-Cosine pulse, the interval has a length of $12T$ and we define $\Delta t = \frac{T}{F_s}$ in which $F_s = 10$, to be able to see the influence of the sampling time error on the error probability we create the pulse for three different scenarios as instructed, in the end we plot the pulses.

In the next section we proceed to create the transmitted signal with the help of the Raised-Cosine and modulated symbols, we do this as instructed in the computer assignment.

In the next section we shall model the AWGN channel, we do this in order to calculate the error probability of symbol detection for the BPAM modulation in an AWGN channel.

Next we proceed to detect the symbols, we do this as instructed in the assignment.

In the end, we shall go on to calculate the error probability by comparing the detected symbols and the modulated symbols, we calculate the error probability using the following formula

$$P_e = \frac{number\ of\ errors}{total\ number\ of\ symbols\ (N)}$$

1 Raised-Cosine pulse generation

Here we created the raised cosine with the aid of the hint embedded in the question and with the help of a for loop and some if conditions then we go on to plot them for different scenarios. [1]

1.1 Raised-Cosine for $\beta = 0$

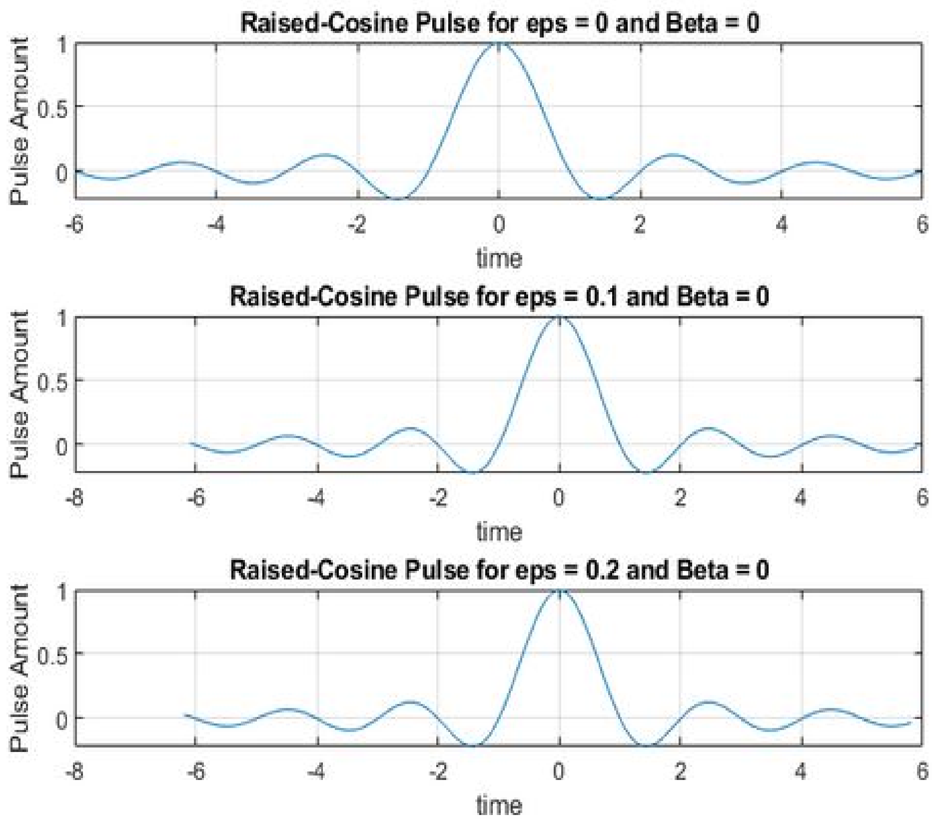

Figure 1: Raised-Cosine for $\beta = 0$

[1] Due to the fact that we need the raised-cosine with roll-off factor 0 and 1 in the future the plots have been added here.

1.2 Raised-Cosine for $\beta = 0.5$

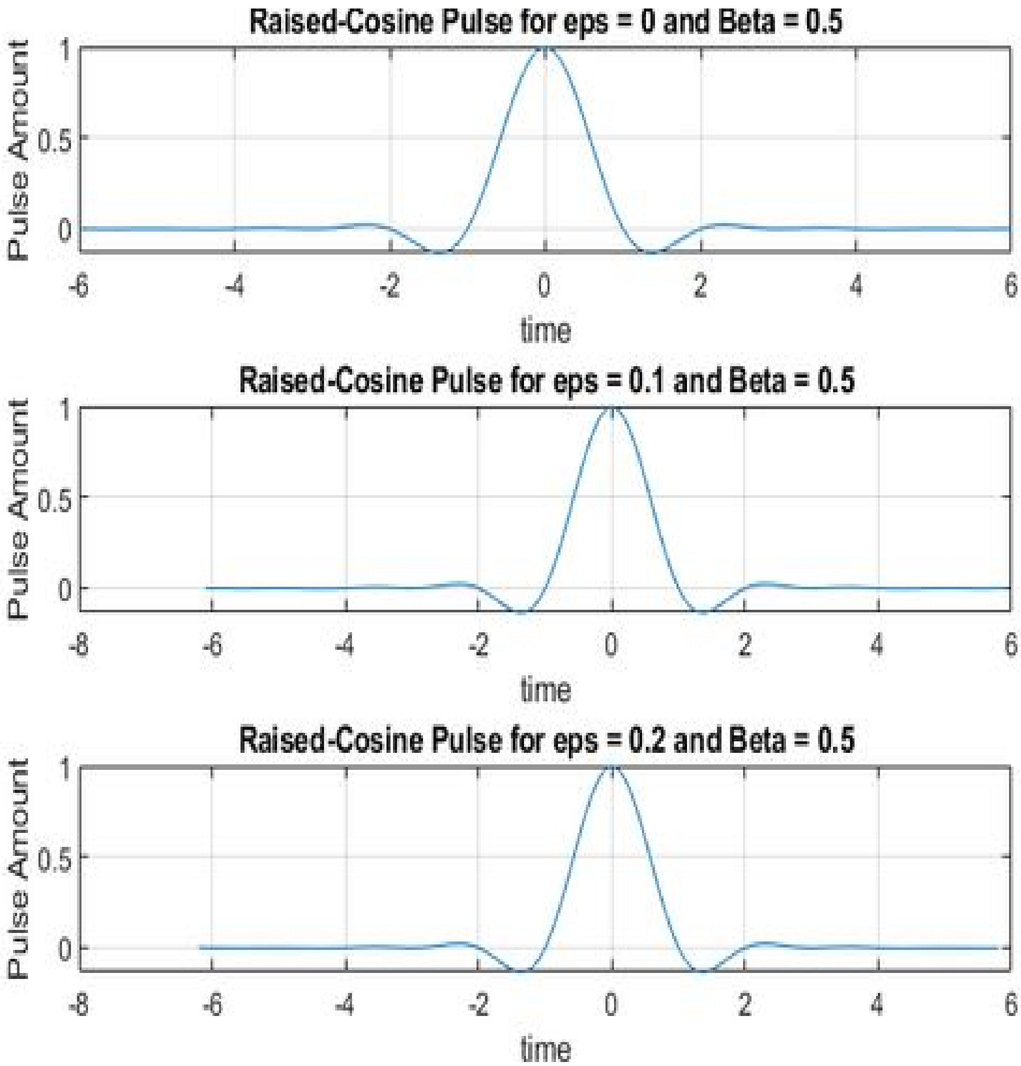

Figure 2: Raised-Cosine for $\beta = 0.5$

1.3 Raised-Cosine for $\beta = 1$

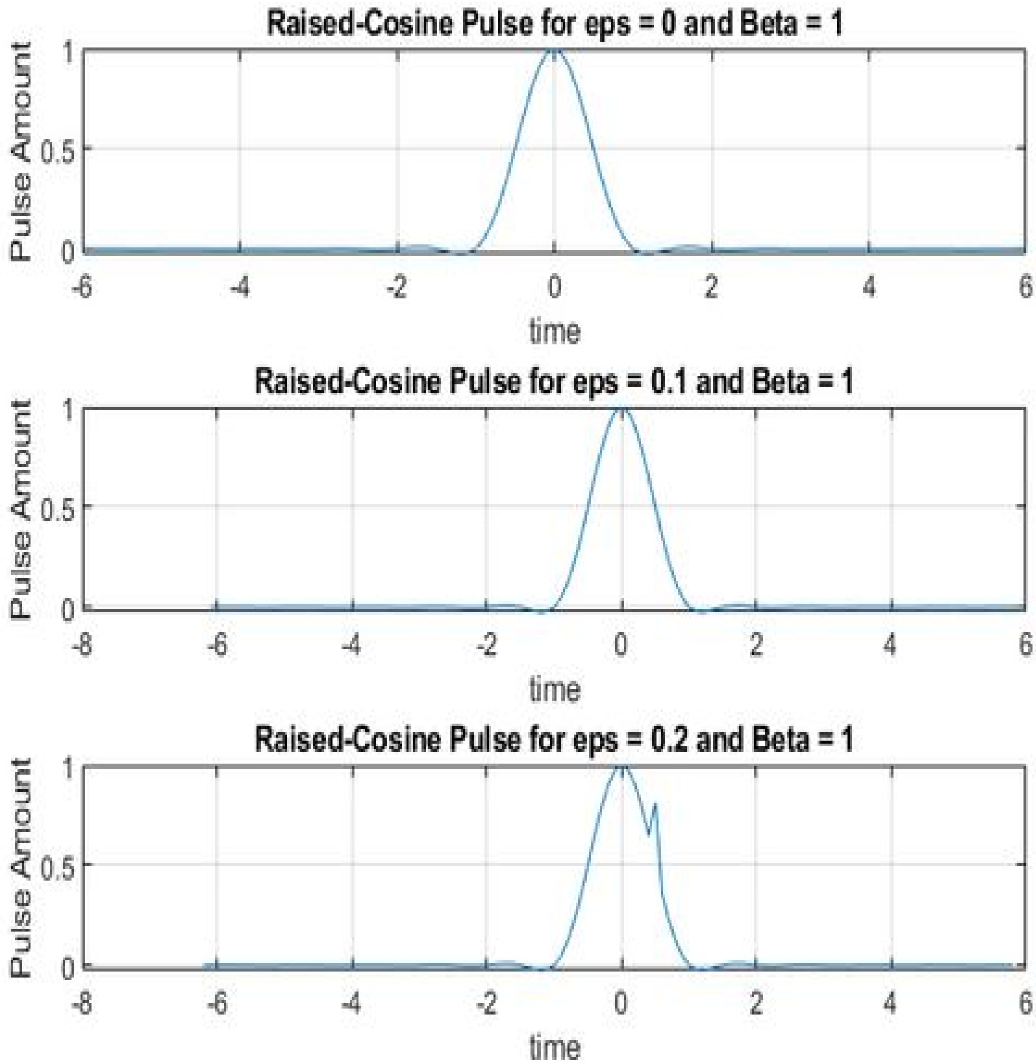

Figure 3: Raised-Cosine for $\beta = 1$

2 Transmission signal generation

We have completed this part exactly as commanded in the assignment. [2]

3 AWGN channel modeling

We have completed this part exactly as commanded in the assignment.

4 Symbol Detection

For brevity, I have created a symbol detector function to abstain from excessive coding in the main body of the assignment.

5 Calculating error probability and plotting

Here we calculate the error probability as requested, then we proceed to plot the needed graphs.

[2] Due to the fact that Dr. Rabiei said that it is better to send 10 million symbols rather than 100 thousand, I opted to create 10 million symbols.

5.1 Plot for $\beta = 0$

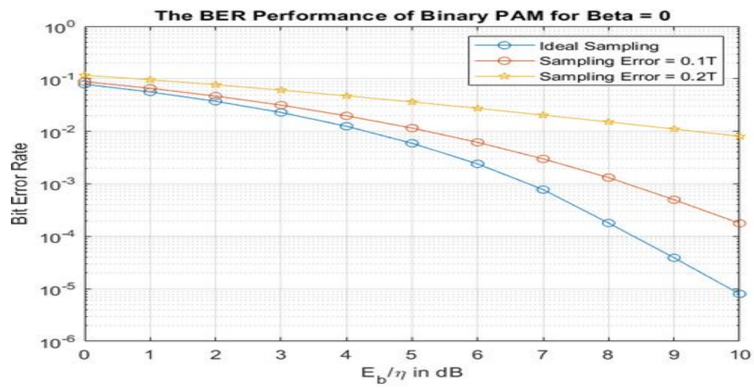

Figure 4: Plot for $\beta = 0$

5.2 Plot for $\beta = 0.5$

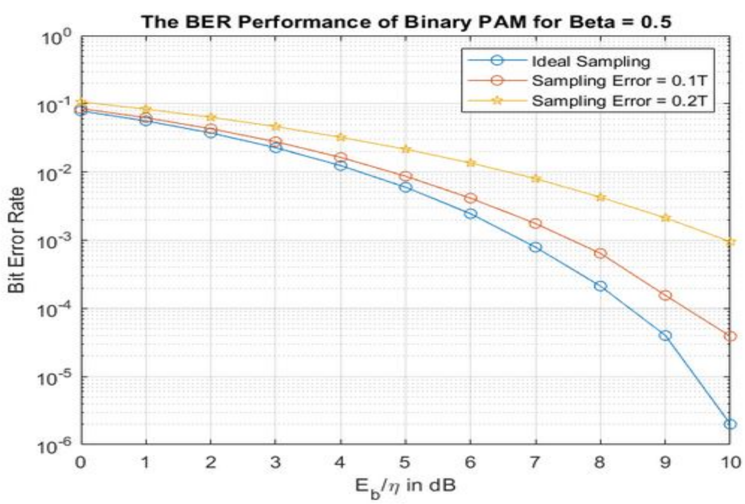

Figure 5: Plot for $\beta = 0.5$

5.3 Plot for $\beta = 1$

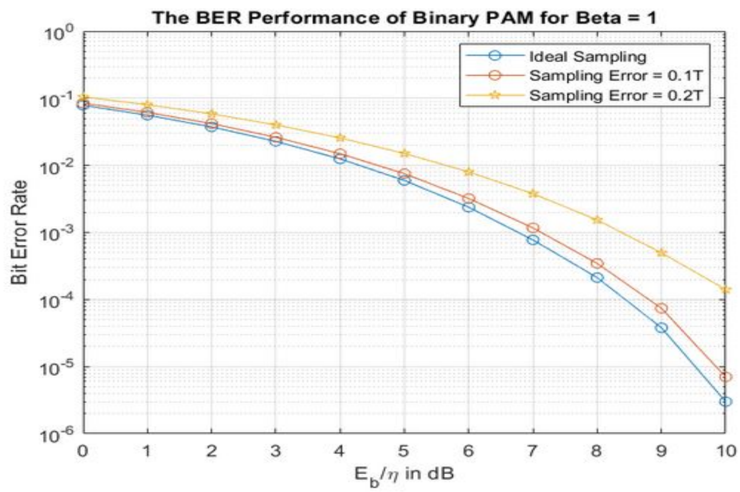

Figure 6: Plot for $\beta = 1$

5.4 Explanation and Analysis

First of all, I'd like to point out the fact that in the generated raised cosines, the ripple is affected by the roll-off factor (β), by increasing β the ripples decrease.

It can be interpreted by our simulation, that by increasing the roll-off factor (β) the error probability increases (this fact is obvious due to the BER performance plots), this phenomenon can be justified by the fact that the sensitivity of the pulse to the ISI caused by the sampling error is less in this case.

We observed that there is a trade-off between sensitivity to ISI and bandwidth which is affected by changing the roll-off factor, so it is not always better to increase β to its limit in order to lessen our sensitivity to ISI, what happens in the real world is that the roll-off factor is set at an amount to satisfy the needs of the modulation and obtain a healthy relationship between the bandwidth and sensitivity to ISI.